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A comparative study of the types of two nivicolous species of myxomycetes: *Lamproderma robustum* and *L. sauteri*

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Abstract — The type material of *Lamproderma robustum* was located, described, and typified. It was then compared with the holotype of *L. sauteri* and their synonymy confirmed. Spore ornamentation of both species was examined with the scanning electron microscope, and microphotographs that illustrate their most important characters are provided herein.

Key words — *Myxomycota*, *Stemonitales*, taxonomy

Introduction

An examination of type material is fundamental for knowing any species of myxomycete well, and this is especially true for the nivicolous myxomycetes that are characterized by wide morphological variation due to the extreme environmental conditions present during their development. These include low temperatures, frost, and abrupt changes in temperature and humidity when the snow melts.

However, locating a type specimen may be a difficult task, particularly when it is very old material. Sometimes its location has not been described in the literature or, if the author did cite a location in the original description, the material may have been moved. Additionally, access to a type may be restricted due to its age or scarcity of the material.

Therefore, investigators frequently turn to the original species description or subsequent descriptions made by other investigators who may not have actually examined the type specimen. Old descriptions often are rather short and their interpretation may be difficult and ambiguous. As a consequence, misinterpretations of taxa are carried on, as in the case of *Lamproderma cribrarioides* (Fr.) R.E. Fr., which had been misinterpreted since its description in 1829. The holotype of this species was examined by Singer et al. (2003) and found to correspond to a variety of *L. atrosporum* Meyl. (i.e., *L. atrosporum* var. *pseudocribrarioides* Mar. Mey. et al.) with completely reticulate spores. The

species attributed to the name *L. cribrarioides* was found to represent a new species — *L. retirugisporum* G. Moreno et al.— that had not yet been properly described.

The later study of *Lamproderma carestiae* (Ces. & De Not.) Meyl. by Poulain et al. (2003) revealed that in reality it represented another *L. atrosporum* variety with non-reticulate spores, i.e. *L. atrosporum* var. *atrosporum* (today: *Lamproderma cribrarioides* var. *carestiae* (Ces. & De Not.) G. Moreno & H. Singer). In this case, different investigators had interpreted *L. carestiae* in different ways, but these interpretations—as happened before—corresponded to new species: *L. zonatum* Mar. Mey. & Poulain (Poulain et al. 2003) and *L. aeneum* Mar. Mey. & Poulain (Poulain et al. 2002).

In the current work we examined the type of *Lamproderma robustum*, described more than a century ago in 1884, and differently interpreted by later investigators who also studied the type material but proposed two very different species as synonyms: *Lamproderma atrosporum* (Dennison 1945) and *L. sauteri* (Lister 1894). Although most myxomycetologists now follow Lister's interpretation, the type material has not been examined again until now, and for the first time scanning electron microscopy has been used to examine the spore ornamentation.

Materials and methods

The examined specimens come from the herbaria NY and STR.

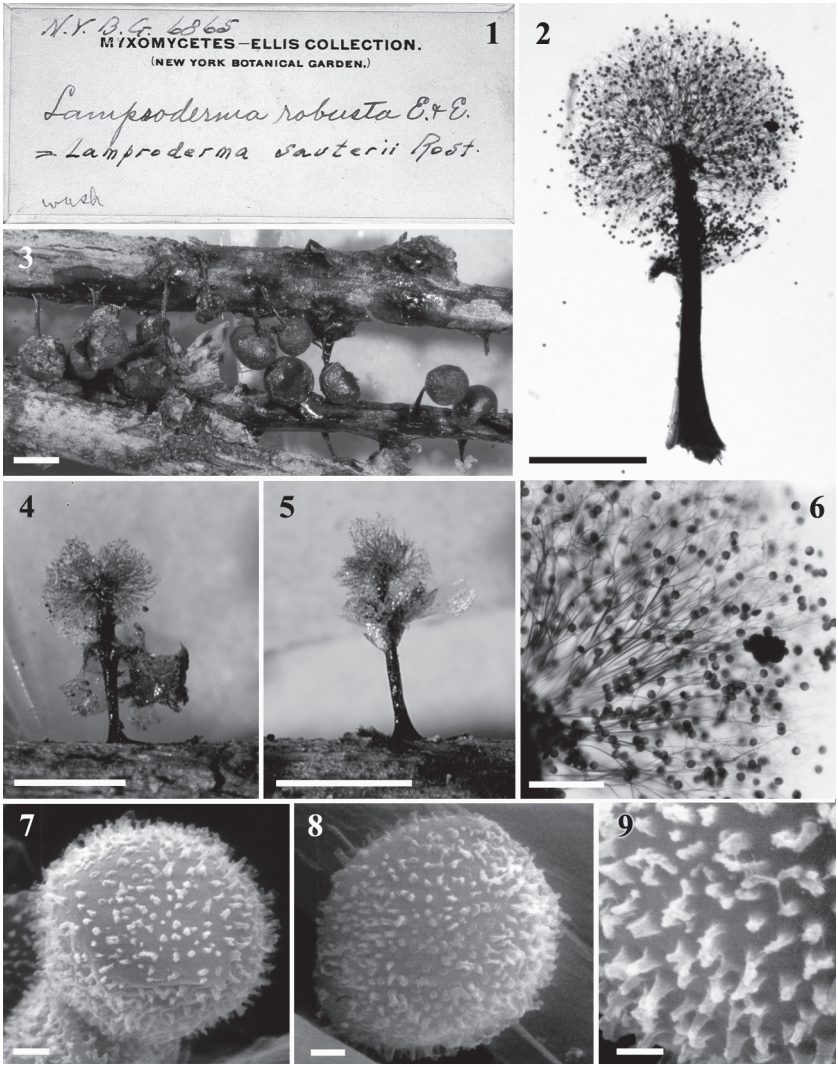
Specimens were mounted in Hoyer's medium and studied with a Nikon microscope. Scanning electron microscopy micrographs were made with a Zeiss DSM-950. Spore measurements were made under the oil immersion objective and include surface structures such as spines or warts.

For ultramicroscopic studies the material was rehydrated in concentrated ammonium hydroxide (28–30%) for 30 minutes, dehydrated in aqueous ethanol (70%) for 30 minutes, fixed for 2 hours in pure ethylene glycol dimethyl ether (= 1,2-dimethoxymethane) and finally immersed in pure acetone for at least 2 hours followed by critical point drying and sputtering with gold-palladium.

Taxonomic description

Lamproderma robustum Ellis & Everh., Bull. Washburn Lab. Nat. Hist. 1: 5 (1884) **Figs. 1–9**

Original diagnosis — Sporangia stipitate, gregarious, globose, 1 mm in diameter, with double walls, the outer wall of which is thin, membranaceous, transparent, and soon falls away, while the inner one is quite permanent, and is of a dull, olivaceous, metallic gray, without lustre; stem stout, black 1 mm high, arising from a distinct, membranaceous hypothallus, and penetrating as a columella to near the center of the sporangium, where it is slightly thickened, and sends out on all sides abundant stout,



Figs. 1–9. ***Lamproderma robustum*** **(holotype). 1.** Herbarium box. **2, 4, 5.** Detail of sporocarp. **3.** Group of sporocarps. **6.** Detail of capillitium. **7–8.** Spores. **9.** Detail of spore ornamentation. Scale bars. 2 = 0.5 mm. 3–5 = 1 mm. 6 = 150 µm. 7–8 = 2 µm. 9 = 1 µm.

branching, olive-brown threads, which combine into a dense net-work; spores snuff-brown, globose, strongly and densely warted, 11.5–13 µm.

Specimens examined — **UNITED STATES. — Washington, Yakima Co.**, Mt. Adams (Mt. Paddo), on woody branches of *Ericameria bloomeri* (A. Gray) J.F. Macbr., IX-1883,

leg. Suksdorf, Nº 47 in *NY 6865* (**HOLOTYPE**), *NY 6863* (**ISOTYPE**). **Kitsap Co.**, Chico, ex Herb. Macbride, Sturgis collection in *NYBG 11332* as "*Lamproderma robustum* = *L. violaceum* var. *sauteri*", is ***Lamproderma sauteri.*** Ibidem, *NY 11333* as "*Lamproderma robustum* = *L. violaceum* var. *sauteri*", is ***Lamproderma sauteri.*** — **CALIFORNIA**, **Idyllwild Co.**, on *Ribes* stems, 24-III-1928, leg. and det. O.A. Plunkett, Southern California *Myxomycetes* nº 232 in *NY* without number: "*Lamproderma robustum* = *L. sauteri*", is ***Lamproderma cucumer.*** **Fresno Co.**, Summit Meadow, near Shaver Lake, ca. 1768 m (5800 ft), on twigs of *Ribes roezlii* Regel, 4-X-1965, leg. D.R. Miller & Bill Paldi, det. Lee Bonar, California Fungi in *NY* without number, as "*L. robustum* Ell. & Ev. (= *L. atrosporum* Meylan)", is ***Lamproderma cucumer*: San Bernardino Co.**, Big Bear Lake, on fallen pine needles, living leaves, 29-V-1927, leg. and det O.A. Plunkett, Southern California *Myxomycetes* nº 217 in *NY* without number, as "*Lamproderma robustum* = *L. sauteri*", is ***Lamproderma echinosporum.***

DESCRIPTION — The type material is distributed in two cardboard boxes. We consider the specimen NY 6865 the holotype of the species (FIG. 1), as the information provided inside the box corresponds with the data indicated in the original diagnosis by Ellis & Everhart (1884). The specimen is very abundant and there are numerous pieces of twigs plentifully covered with sporocarps stuck to the inner side of the upper box lid and the small laterals of the lower part of the box, in the centre of which a handwritten note is stuck with a large "47" written in blue ink and the following text in black: "*Lamproderma robusta* E. & E., on woody branches of *Aplopappus bloomeri*, Mt. Paddo W.T., Sept. 83. W.N.S., Dr. Rex thinks this is *L. arcyrioides*". Quite a few of the sporocarps are collapsed or old, but others are in rather good condition. We regard the collection NY 6863 as an isotype, which is less copious and consists of only three small pieces of twigs of *Ericameria bloomeri* fixed to the inner side of the upper box lid, bearing many very well fructified sporocarps. In the lower part of the box there is a rectangular peace of wood with a label stuck on it containing the following information handwritten with India ink: "*Lamproderma robusta* Ell. & Evrht., on twigs of *Aplopappus bloomeri*, Mt. Paddo Washington, Sept. 1883. W.N. Suksdorf".

We provide the following description of the holotype:

Sporocarps gregarious to aggregated, stalked, 1.5–2 mm total height. Sporotheca (FIGS. 2–5) globose, 0.7–1.2 mm diam., iridescent with blue, violaceous or bronze reflections. Hypothallus membranous, reddish brown, common to several sporocarps. Stalk same height as sporotheca or 1.5 times its diameter, widened in the base, blackish by magnifying glass. Peridium simple, irregular dehiscence, breaking easily and persisting in the base. Columella reaching half the height of the sporotheca, cylindrical or tapering toward the apex, blackish by light microscope (LM). Capillitium (FIG. 6) radial, originating in the upper part of the columella, moderately branched in the center of the sporotheca, more branched towards the periphery, reddish brown to dark reddish, clearer and thinner towards the outside. Spores (FIGS. 7–8) globose, 13.5–14.5(–15) µm diam., dark brown in mass, dark violaceous with a clearer zone by LM, spiny.

When examined with the scanning electron microscope (SEM), densely and regularly distributed baculae can be observed (Fig. 9).

Comments — We agree almost completely with the original description, with the exception of the color of the different portions of the sporocarp—possibly due to the subjectivity of the observer—the presence of a double peridium—absent in the genus *Lamproderma* that always has a single membranous peridium—and spore size, 13.5–14.5(–15) µm diam. according to our observations and 11.5–13 µm in the original description.

It calls our attention that the type specimens were collected in September, because the majority of the nivicolous myxomycetes are found in spring, when snow melts in the mountains, which—depending on the elevation—can last until the summer months of July or August. But we have to take into account that the site of collection, Mount Adams (referred to as Mount Pahto by the natives and Mt. Paddo by Suksdorf) is a high volcano (3742 m), the upper cone of which is covered by ice (mostly in the form of glaciers) and is fed by ample snowfall every year, which would explain why these specimens were gathered in autumn. Furthermore, it is possible that we are dealing it with an old fructification that had developed in late summer and was not picked up until September. This would explain the rather poor condition of the specimens.

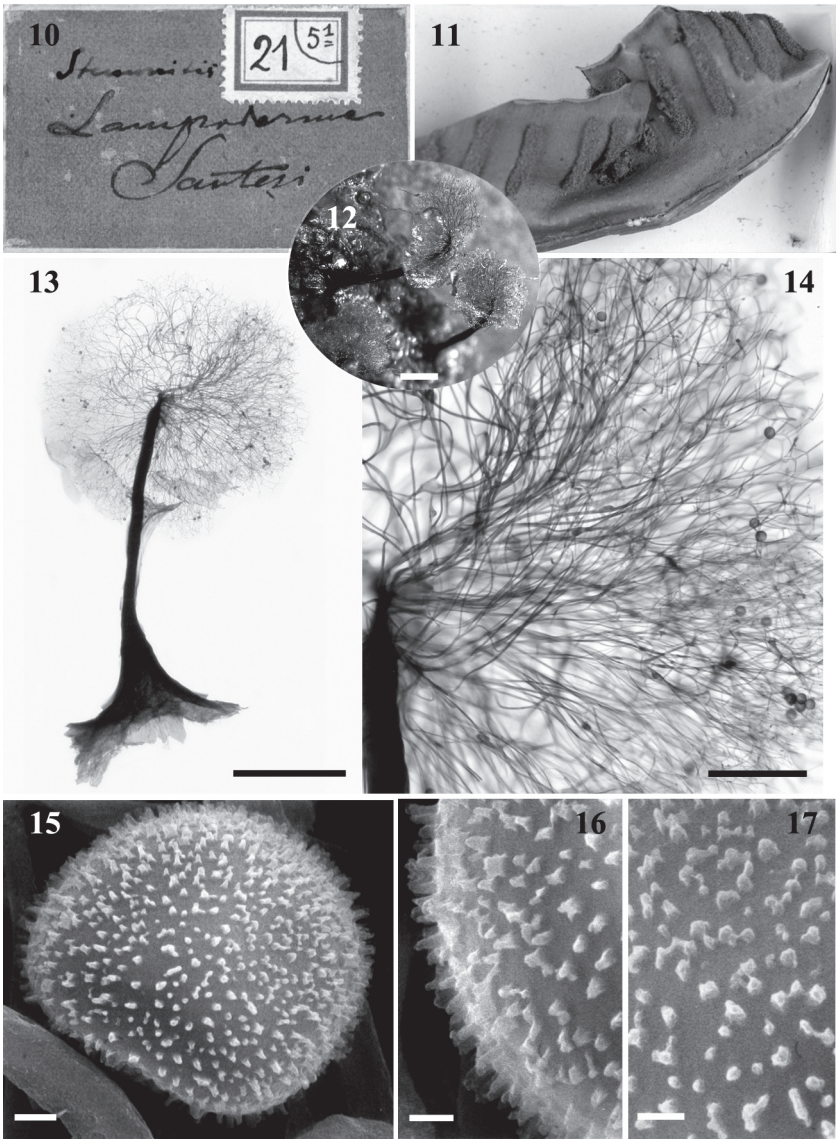
The substrate is *Ericameria bloomeri* (A. Gray) J.F. Macbr. (rabbitbush) (≡ *Haplopappus ["Aploppapus"] bloomeri* A. Gray), a many-branched shrub reaching a maximum height of about half a meter that is native to the mountains of western North America where it grows in coniferous forests up to approximately 1800 m.

Lamproderma sauteri Rostaf., Sluzowce Monogr.: 205 (1874) **Figs. 10–17**

Original diagnosis — English translation from Polish original description: Similar to the previous species (*Lamproderma violaceum*), more robust in all its elements. The sporangia are globose, slightly flattened towards the base, 1 mm broad, shiny, with a metallic iridescence. Stalks black, shiny, originating from a common, very well developed and robust hypothallus; the stalks turn inside the sporangium in an exactly cylindrical columella, truncate at the apex. The filaments of the capillitium are much branched, they frequently divide, almost from its base, forming a very dense net. Capillitium light brown after spore dispersion. Height of the sporangium, including stalk, 2 mm. Spores dark violaceous, very spiny, 12.5–15 µm, large.

Specimens examined — **AUSTRIA**, **Salzburg**, 1863, on frond of *Phyllitis scolopendrium* (L.) Newman (≡ *Asplenium scolopendrium* L.), herb. Rostafinski 21-51 in *STR* without number (**holotype**).

Description — The type material is kept in a small cardboard box, which bears a stamp on its outer side with the numbers 21 and 51 handwritten with black ink (Fig. 10). In the inside of the box there is card with a part of a fern frond with sori of *Phyllitis scolopendrium* stuck on it (Fig. 11). The sporocarps



Figs. 10–17. ***Lamproderma sauteri*** **(holotype). 10.** Herbarium box. **11.** Fern frond with sori. **12.** Group of sporocarps on sori. **13.** Detail of sporocarp. **14.** Detail of capillitium. **15.** Spore. **16–17.** Detail of spore ornamentation.

Scale bars. 12–13 = 0.5 mm. 14 = 150 µm. 15 = 2 µm. 16–17 = 1 µm.

are few in number, almost entirely lack a peridium and spores, and can be found primarily between the sporangia of the sori. The macro- and microscopic description is identical to the description provided for *Lamproderma robustum*, with the following differences in measurements and colors: Sporotheca (Figs. 12–13) 0.8–1.5 mm diam. Capillitium (Fig. 14) reddish-brown to orangeish, clearer towards the periphery. Spores (Figs. 15–17) 13–16 µm diam.

Comments — *Lamproderma sauteri* has been cited from Spain and described by Moreno et al. (2003). Later, Poulain et al. (2003) studied the holotype of this species, which has been reexamined by us. There are no significant differences between our observations and the original description of the species.

Discussion and conclusions

According to the information available in the literature, Massee (1892) was the first to reexamine the type of *Lamproderma robustum* after its description in 1884. He studied a portion of the type provided to him by Mr. Wingate and observed minutely warted spores, 9–10 µm diam., separating it from *L. sauteri* with its larger spores, 12–15 µm diam., densely covered with spinules.

Lister (1893), in his monograph on the myxomycetes, studied the same type portion already examined by Massee but disagreed with Massee's observation, noting instead strongly spinulose spores, 11–13 µm diam., and considering it "almost identical with the type of *Lamproderma sauteri.*" Lister considered both species to represent a variety of *L. violaceum*, which he named *L. violaceum* var. *sauteri* (Rostaf.) Lister, characterized by a brown capillitium, spores 11–15 µm diam, and nearly smooth or spinose. He retained this view in both the second and third editions of his work (Lister 1911, Lister & Lister 1925).

Macbride (1899), in the first edition of his monograph Myxomycetes of North America, treated the two species *Lamproderma robustum* and *L. sauteri* as synonyms. In the second edition of his work (Macbride 1922), however, he emphasized that *L. robustum* differed from *L. sauteri* and was "well defined, not a variety of anything", making a clear reference to Lister's proposed variety, *L. violaceum* var. *sauteri*. Macbride (1922) here characterized *L. robustum* principally by its persistent basal peridium, its very dense and much branched capillitium forming a delicate network with abundant free ends in the surface, and large (14–16 µm diam) spores.

Graff (1928) created the variety *Lamproderma sauteri* var. *robustum* (Ellis & Everh.) P.W. Graff, based on a collection on *Pinus ponderosa* Dougl. from northwestern Montana in the United States. Graff regarded this variety as being very close to *L. sauteri*, "too close (…) to be considered separate from it, but distinct enough for varietal status," and characterized it by a much branched capillitium, dark to purplish brown, forming a fine-meshed network in the

surface and minutely echinulate, 12–15 µm diam. spores.

Dennison (1945) compared type material of *Lamproderma robustum* with collections of *L. atrosporum* (currently recognized as *Lamproderma cribrarioides* var. *carestiae* from Switzerland) and considered them "identical in essential respects" for sharing widened capillitium terminations, spores of similar size, color and ornamentation, the same general structure and growth habit. Because *L. robustum* is the older name, he maintained it, treating *L. atrosporum* as a synonym. Dennison distinguished *L. robustum* from *L. sauteri* by its dark spores with a warty ornamentation tending to form a reticulum and the widening of the capillitium tips.

Martin & Alexopoulos (1969) cited *Lamproderma robustum* as a synonym of *L. sauteri*, as did Kowalski (1970) in his monograph on the genus *Lamproderma*. Today, Hernández-Crespo & Lado (2008) follow the same taxonomic treatment.

In conclusion, the several investigators who studied the type material of *Lamproderma robustum* have come to different conclusions. While Massee (1892) and Macbride (1922) corroborated that it is an independent species, the first one giving spore characters that we have not been able to confirm, Lister (1893) considered the two species *L. robustum* and *L. sauteri* to represent a variety of *L. violaceum* Fr. ex Rostaf. The interpretation by Dennison (1945) is especially noteworthy, as *L. robustum* has nothing in common with *Lamproderma cribrarioides* var. *carestiae*. Therefore, we doubt that Dennison actually studied authentic type material of *L. robustum*.

We have examined other specimens deposited in the herbarium NY and determined as *Lamproderma robustum*, among them two collections from the Macbride herbarium (NY 11332 and NY 11333), which consist of limited material but are excellently conserved. The Macbride specimens correspond without doubt to large-stalked *L. sauteri,* described by Meylan as *L. sauteri* f. *gracile* Meyl. Contradictorily, Macbride described *L. robustum* in his monograph with a short stalk (Macbride 1899, 1922). However, Martin & Alexopoulos (1969) had already pointed out that adverse environmental conditions during fructification development may cause excessively large stalks and we consider these long stalked forms as lacking taxonomic significance.

The two specimens determined by O.A. Plunkett as *Lamproderma robustum* belong to two different *Lamproderma* species. Collection #217, which has globose sporothecae, a mottled peridium, a dark radial capillitium and spores 13–15 µm diam., with a strong spiny to shortly crested, lax spore ornamentation, represents *L. echinosporum* Meyl. Specimen #232 shows an ovoid to ellipsoid sporotheca, very short stalk, dark abundant capillitium with straight branches and dark expansions at the branching points, and 12–13 µm diam. spores that are densely covered by small warts. It corresponds to *L. cucumer* (Meyl.)

Nowotny & H. Neubert. The collection without a number determined by Lee Bonar as *L. robustum* presents the same characters as Specimen #232 and corresponds as well to *L. cucumer*.

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